THE EFFECTS OF CHEMICALS USED ON STRAWBERRY CROPS ON INTRODUCED PHYTOSEIID MITES

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SUMMARY

Chemicals commonly used on strawberry crops in Canterbury were shown to increase the duration of the egg stage of two species of phytoseiid predatory mites. Residues on strawberry leaves produced a repellency response in adult female phytoseiids and also decreased the rate at which they deposited eggs. Many commonly applied chemicals were toxic to one species, *Amblyseius fallacis*, at recommended field rates.

INTRODUCTION

Two species of organophosphate (OP) resistant phytoseiid mites, *Amblyseius fallacis* and *Typhlodromus occidentalis*, were introduced into New Zealand in the early 1970's (Thomas and Chapman 1978). The suitability of these mites for twospotted spider mite (TSM) control, under New Zealand conditions, in various horticultural crops has been the subject of recent research (Thomas and Chapman 1978; Penman *et al* 1979). *Typhlodromus occidentalis* has been released into strawberry crops in Canterbury (Penman *et al* 1979) and Hawkes Bay (Walker 1979) with mixed results.

In California the success of phytoseiid mites in controlling TSM in strawberry crops is well documented (Oatman and McMurtry 1966; Oatman *et al* 1967; 1968; 1977). The different cultivars of strawberry plants grown, species and strains of phytoseiid mites used, climatic conditions and cultural practices between California and New Zealand necessitated the evaluation of these two species for this role in New Zealand.

This paper describes the effects on *A. fallacis* and *T. occidentalis* of chemicals applied for pest control in strawberries. Twospotted spider mites are not the only pests of strawberries and consequently chemicals applied to the crop for fungal disease, leafroller, aphid, weevil and wheatbug control as well as those currently used for TSM control may have a detrimental effect on phytoseiid predators. The destruction of natural enemies by pesticides can allow the target population to recover rapidly after spraying and possibly reach higher infestation levels than before treatment (Smith 1970). Wong and Chapman (1979) found that the recommended application rates of cypermethrin and fenvalerate would cause a high mortality of *A. fallacis*, *T. occidentalis* and *T. pyri* in the field but gave little control of TSM.

Field releases of the phytoseiids into strawberry, cv 'Redgauntlet' have indicated *A. fallacis* gives better control of TSM than does *T. occidentalis*. Both species failed to overwinter well and recovery in subsequent seasons did not occur. 'Control plots', without predators or sprays, returned the same yields as did the release plots (Butcher unpubl. data).

Integrated control of TSM is now well established in New Zealand (Penman *et al* 1979) but its success depends upon grower adoption of new spray programmes, not detrimental to the predators (Wearing and Ashley 1978; 1982). Therefore continued appraisal of the effects of recommended chemicals and new registrations, on predator populations is essential. Consequently the effects of 10 chemicals commonly used on strawberry crops in Canterbury were tested for their effects on eggs and adult female phytoseiids.

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METHODS

The effects of direct contact with chemicals by adult female predators and their eggs were examined, as were the effects of chemical residues on these predator stages. Thirty phytoseiid eggs, newly laid on bean leaf discs, were sprayed using an airbrush with field rates of 10 chemicals commonly used on strawberries in Canterbury (Table 1). Water/acetone was used as a control. Eggs were allowed to air dry and then were held at $20^{\circ} \pm 2^{\circ}\text{C}$, 70% RH. They were checked daily for hatching.

The slide-dip technique (Anon 1974) was used to test the contact toxicity of the same 10 chemicals, each at six rates, on female *A. fallacis*. Thirty adult females were attached dorsally to a glass slide with double-sided tape, dipped for five seconds and held at $20^{\circ} \pm 2^{\circ}\text{C}$, 70% RH for 24 h. Mortality was assumed if the mites failed to respond to being touched with a fine camel hair brush, by extending and retracting one or more limbs. Female *T. occidentalis* were not tested because the culture was contaminated with and destroyed by *A. fallacis*.

The effects of chemical residues on adult female survival and egg deposition were monitored by spraying 120 strawberry leaf discs with the same chemicals at the same rates used in the slide-dip trials. After spraying, the leaf discs were air dried. Sixty discs were infested with an abundant supply of all stages of TSM and up to 10 mated adult female phytoseiids depending upon predator availability. The number of females dead and the number of eggs deposited were recorded 24 h and 72 h after spraying. This procedure was repeated using the remaining 60 leaf discs 72 h after spraying, mortality and fecundity being recorded 96 and 144 h after spraying. To ensure results were due to chemicals and not diminished nutritional value of the TSM food source (leaf discs) the same discs could not be monitored for six days, hence the second release. All trials were held at $20^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and 70% RH.

TABLE 1: Effect of chemicals, used on strawberries, on eggs and adult females at phytoseiid mites.

TREATMENT		<i>T. occidentalis</i>		<i>A. fallacis</i>		
Chemical	Formulation	Field Rate g ai/litre	% Egg Hatch After 6 Days	% Egg Hatch After 6 Days	Adult LC ₅₀ g ai/litre	95% CI
Fungicides						
copper oxychloride	50% WP	2.50	100	100	16.54	2.06-700.1*
dichlofluanid	50% WP	1.25	100	100	3.86	0.59- 80.8*
benomyl	50% WP	0.23	21	87	0.34	0.06- 4.0
thiram	80% WP	2.50	77	100	166.74	1.64-214040*
Insecticides and Acaricides						
cyhexatin	50% WP	0.20	100	100	0.74	0.12- 19.5
demeton-S-methyl	53% EC	0.25	75	100	0.15	0.034- 1.2
azinphos-methyl	50% WP	0.20	67	100	1.69	0.17- 89.0*
mevinphos	1230g/l EC	0.37	100	100	0.11	0.02- 0.8
dichlorvos	1080g/l EC	0.92	100	100	0.03	0.003- 0.1
pirimicarb	5% EC	1.14	100	100	0.26	0.05- 1.5
control	—	—	100	100	—	—

*large CI's correspond to phytoseiid tolerance of that chemical.

Trade names of chemicals used:

dichlofluanid — Euparen
benomyl — Benlate
thiram — Thiram
cyhexatin — Plictran
demeton-S-methyl — Metasystox

azinphos-methyl — Gusathion
mevinphos — Phosdrin
dichlorvos — Vapona
pirimicarb — Pirimor

RESULTS AND DISCUSSION

The pesticides used in these trials include four fungicides for control of *Botrytis* and some leafspot infections. Cyhexatin, a specific acaricide; demeton-S-methyl and pirimicarb for aphid control; azinphos-methyl for lepidoptera (especially leafroller); mevinphos for wheatbug and thrip. Dichlorvos is used as a general clean-up insecticide close to harvest. Almost weekly applications of the fungicides, especially after flowering starts; demeton-S-methyl and cyhexatin prior to flowering, mevinphos, when required; dichlorvos, if required, during flowering with azinphos-methyl and cyhexatin after harvest are used to keep plants healthy and the crop at top quality.

The results of direct contact with chemicals for phytoseiid eggs and adult females are summarised in Table 1. Adult mortality data was analysed using the POLO log-probit model of Russell *et al* (1977). Most chemicals, directly applied to phytoseiid eggs, increased the duration of the egg stage in both species. After 6 days, four chemicals still exerted a prolonging effect on egg development of *T. occidentalis* but, in both species, in all except the benomyl trial, 100% egg hatch was achieved by the eighth day. Normally under the ambient conditions of these trials *T. occidentalis* eggs would hatch in 2.1 days and *A. fallacis* eggs in 1.7 days (Butcher unpub. data). Benomyl reduced the viability of *T. occidentalis* eggs to 58% and those of *A. fallacis* to 87%. Chemical residues on plant leaves did not kill adult phytoseiids directly but caused an avoidance response (repellency) which resulted in the mites being drowned in the surrounding wet cottonwool. Benomyl caused a 20% mortality in *T. occidentalis* females due to repellency but no mortality in *A. fallacis*. In the first test mevinphos repelled 17% and 20% of *T. occidentalis* 24 and 72 h after application, respectively. No further avoidance was detected on the older (96, 144 h) residues. Fifty percent mortality, on mevinphos, due to repellency was recorded for the corresponding time periods for *A. fallacis* but not on the older residues. The rate of egg deposition by *T. occidentalis* was generally suppressed on residue coated leaf discs when compared to the water/acetone control, especially over the first 72 h after spraying. In this species egg deposition reached its control level four days after application in all trials. Egg production rates of *A. fallacis* varied much more than those of *T. occidentalis*. In some cases; copper oxychloride, mevinphos, demeton-S-methyl and dichlorvos appeared to slightly enhance egg production, whereas in other cases; dichlofluanid, benomyl, thiram and azinphos-methyl, lead to reduced egg production.

CONCLUSIONS

Integrated mite control requires careful integration of chemical and biological factors, with an awareness of the impact of pesticides being essential. Fungicides can be used at field rates with little adverse effect, although benomyl will stimulate an avoidance reaction in adults and decrease the viability of eggs. In an integrated control system benomyl would need to be replaced by thiram or dichlofluanid. Only cyhexatin and azinphos-methyl can safely be used at the higher recommended rates. If *A. fallacis* was released into a crop, very low rates of mevinphos, dichlorvos and demeton-S-methyl would need to be used to maintain predator survival. Pirimicarb, newly registered on strawberry, would not be a suitable substitute for aphid control. With some reorganisation of spray schedules, *A. fallacis* would reduce the number of acaricidal sprays required each season. The possible reduced level of control of other species by this reorganisation may negate any benefit gained in mite control. The apparent tolerance by 'Redgauntlet' to TSM feeding in Canterbury, with no detectable yield reduction also suggests potential for reduced acaricide inputs and costs in this growing region.

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